AARON'S CODE

Meta-Art, Artificial Intelligence, and the Work of Harold Cohen

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The Painter's Tale

Here's a tale I'll tell about a painter; a golden boy from the moment he enters London's Slade School of Art, magic in his fingers, his paintbrushes; winning the prizes that bring him notice and honor, the chance to travel. The usual grabbing then: teaching at art schools, furniture-making, a post at a provincial university for three years. Then comes the Commonwealth Fellowship, two years in New York City, friendships with the American abstract expressionists. Home again: perhaps not exactly famous, but remarked, known. Changed.

In 1966, 15 years after he's left the Slade, nearing age 40 and in full command of his art, he's named one of five artists to represent Great Britain in the Venice Biennale, then the most important international art exhibit in the world.

Intoxicating joy: deep, gratifying. He understands he could be set for life. The scrambling and scrimping, the painting from midnight to four A.M. because earning a living takes up the rest of the time—all that could be over if he wants. His London dealer gives him a contract so that he can paint full-time; he can be certain that every year the Tate will buy a painting or two (and also give him midcareer and lifetime retrospectives), homage that will translate into sales to other museums, to private collectors. Pleasant teaching positions are offered, the BBC asks for occasional addresses, theaters for production designs, merchant houses for textile designs.
His work is collected by national museums; his opinions are sought by the art journals; he's welcomed at soignée parties with other celebrities (for he himself is now a celebrity, a name to be dropped knowingly by acquaintances—and others even more distant). Important commissions appear. It's London of the swinging sixties: Beatles, Stones, Carnaby Street, anarchy; the painter a man of passionate magnetism, slightly exotic: he has his pick of women.

Not two years later, the painter turns his back on all that. Willingly—no, willfully—he enters a spiritual and geographical wilderness, leaving behind everything and everyone he knows, save his children. To be sure, this withdrawal is meant to last only a year: 12 months of reappraisal to allay a dissatisfaction, to name and then banish an unhappiness, to realign. And then resume.

But the wilderness has its own claims, its own schedule. One year turns to two, then five, the painter obsessed by a most private and particular vision. Which stubbornly eludes him. After three years, he fears he's a failure; he's gambled a career and lost.

After five years, he knows it. He sees no choice but to renounce the pursuit.

He salvages this: Perhaps, just perhaps, he's more certain now of what the vision might have been. And that's something. The dancing light that beguiled him in the beginning had been maddeningly shapeless for so long. There are intimations of the shape it will someday take for some other fortunate artist, born later, cleverer, wealthier. In a most private anguish, he resigns himself to the idea that whatever the vision will be, it won't be for him.

Chastened, uncharacteristically humbled, he undertakes a kind of public journey of penitence, sharing fragments of the vision—for even fragments can be useful to those with open eyes. When that too fails, he's left with nothing. Driven back to his obsession, he means by sheer strength of will to grasp that vision and make it yield. Anyway, by now he has nothing left to lose except the rest of his life.


Beginning his sixth decade—wild with ideas and working a young man's hours, growling at time and fools equally, one part benevolent wizard, one part grouch, one part the evergreen young man who paints to take the breath away—the painter stops for a moment to listen with curiosity while someone else tells his tale. And finally understands the obsession as ineluctable, a destiny he prepared for and passionately courted all his life. Win or lose.

The obsession, the fate, is bound up with the most important ideas of the times. It touches and eventually will change the very nature of art itself: the relation of artists to art in general and to their art objects in particular. Art vaults to a level that represents what has never before been possible to represent.
The painter of my tale acts, as artists often do, in the way of a prophet. He’s among the first to sense, to know, to see a change the rest of us will know in our own ways much sooner than we dreamed.

Here’s a tale the artist tells about himself. In 1968, the painter Harold Cohen wrote his first computer program. It had nothing to do with art, the profession he’d pursued with deep seriousness and considerable public success for 15 years, sometimes in his native London, sometimes in New York. Instead, Cohen was responding to the invitation—perhaps the challenge—from a student who claimed he could teach Cohen something new, something that the painter thought might be fun, might refresh him intellectually.

That something was computer programming. Cohen was an artist and certainly didn’t know anything about computers, let alone programming. Still, for several months he worked at learning Fortran, carrying his program over to the computer center at the University of California at San Diego, where he was a visiting faculty member in the art department for the year. He was pleased when his programs ran; he debugged them when they didn’t.

It was soon apparent to him that computer programming languages were a form of representation—rules, instructions, procedures, leading to action. Representation was one of the essential things art was about. That a computer program might represent knowledge that led to the act of making art was not apparent, but after six months of programming, that idea also came to him. It changed his own art-making forever.

Years later, here’s what everyone can see. A relatively modest computer, a MicroVax II, found in any medium-sized office in the mid-1980s, and beside it, connected by a few feet of cable, a drawing machine moves into action. The drawing machine is a large, tablelike affair, supporting an arm with a pen that glides across the paper, slowly producing an elaborate inked drawing of human figures surrounded by dense vegetation. Well, not so slowly: the ensemble could do five such drawings a day if asked—and it thinks faster than it can draw: the conception, the planning takes between 20 minutes to an hour of CPU time, depending on the complexity of the drawing.

Fittingly for its time, the drawing ensemble is a droll hybrid of new and old technologies. The controlling computer works silently, swiftly—to the viewer, perhaps mysteriously. The drawing mechanism, on the contrary, squeaks ink across the paper, which itself is fixed to the table surface by a vacuum that pummels the auditory nerves.

And so a drawing begins to emerge. Its elegant lines haven’t been preplanned except in a very general way. It’s a computer program, called Aaron, that autonomously decides whether human figures will appear in the drawing, how many, which gender, and where; it’s a computer program that chooses which plants will be in the background—or the foreground—and how they’ll look. Aaron decides where and
with what image the drawing should begin. Aaron decides when it’s finished.

Each of Aaron’s drawings is unique: new and different from the one before it, and different too from the one that will follow, yet each with a characteristic style, recognizably Aaron’s. The austerity of Aaron’s lines contradicts all the flashiness usually associated with “computer art”—fastidious detail repudiating electronic glitz. And yet, a human artist wouldn’t, perhaps couldn’t, produce so many drawings of such extraordinary complexity.

Aaron is a semi-intelligent program. That is, it conceives and draws its pictures but doesn’t then quarrel with critics, gallery owners, or even...
Harold Cohen. It has no perceptual apparatus to "see" what it imagines (though we now know that what humans perceive is very much a function of our internal symbolic structures, shaped by a long acculturation process, and Aaron has these to an extent). Lacking eyes, lacking interests beyond its own drawings, can Aaron pretend to intelligence at all? In other words, is intelligence all-or-none?

Aaron is artificial intelligence, intelligence in vitro—not the whole complex of intelligent behavior as we've come to recognize it in humans. Instead, artificial intelligence is certain significant parts of intelligent behavior, cultured in silicon for the same reasons that cells are cultured and studied: to understand the parts as a step toward understanding the whole. This may be the most problematic issue for those who believe that intelligent behavior, once separated from a fully functioning general intelligence, can no longer be considered truly intelligent.

Aaron is, moreover, a contingent system, a member of a class of important systems whose behavior we are only just beginning to understand with precision, now that the computer allows us to study these systems in the small and the large. Aaron is neither deterministic nor nondeterministic (in the classical sense meant by philosophers): the program follows rules, yes, but random events and feedback crowd in at every decision point, forcing the system into "legal" but unpredictable paths. This is how one of Aaron's drawings emerges, none identical to another.

Knowing the rules permits us to trace the genealogy of such a system's behavior, but even with the rules, predicting its future behavior in any detail is nearly impossible. Some call these systems adaptive, since they adapt to a changing environment, but I prefer contingent systems, with the implication that sometimes the environment is so difficult that the system cannot adapt, and so must fail.

To be sure, contingent systems have always existed. Darwin himself recognized that biological evolution was driven by broad laws, but that contingency—chance—has given us life as we know it: the proliferation of species, their deaths, their survivals, their metamorphoses, all depending on local details. Thus, nature emerges not versus nurture but in subtle, wondrous combination with it. And then, at a glance, we begin to see such systems everywhere: the human immune system, the way an individual human develops, ecological systems, weather patterns, national political systems, economies, corporations, languages, human organizations of many kinds; their processes rule-based but their outcomes (or products) unpredictable.

Economist Peter Drucker says that these information-based systems are central to the coming century's new realities. In his words, they "are configurations, and as such, call for perception as much as analysis: the dynamic disequilibrium of the new pluralisms, for instance; the multi-tiered transnational economy and the transnational ecology; the new
archetype of the 'educated person' that is so badly needed.

In short, we are to see the new realities as much as think about them.

The program called Aaron makes the same demands of us. Understand Aaron, and we begin to grasp the behavior of systems all around us, art as insight once more.

And foresight. For although Aaron runs on a serial, not a parallel, computer (one processor, not multiple processors), its performance in the 1970s and 1980s prefigures—pun intended—much that is most interesting in computing in the 1990s. To wit, the program has no central authority; autonomous agents within the program communicate directly with each other; overall cooperation emerges from local optimization, and adaptation replaces direct control.

Aaron raises questions of another nature, too. For example, consider the circumstances as they were in the spring of 1988, when three copies of Aaron were on exhibit around the United States, each drawing pictures simultaneously, each producing a different drawing every time, potentially 20 a day, into eternity.

That alone must give us pause—the sheer numbers, yes; and the fascinating paradox that is one enduring effect of the computer: unique artifacts, one of a kind, the dearest essence of art, coupled puzzlingly, provokingly, with mass production. Another paradox: though the drawings come from a computer, the very emblem of twentieth-century speed, they themselves invite sustained scrutiny from the viewer.

What does such scrutiny yield? A relentless celebration of (can it be?) nature is taking place, from an organic world of simple clouds and nameless creatures in Aaron's early drawings to the later, more mature frondescent jungles, peopled by half-naked innocents, all enough to enrapture either Rousseau, Jean-Jacques or Henri. What on earth shall we make of that? Is the artist putting us on?

And if that isn't enough, Aaron raises questions about identity—its own, the artist's; about the very nature of art itself.

We long for Walter Benjamin to rise up and reconsider the work of art in the age upon us, an age filled with machines but no longer mechanical; an age that reproduces not objects, but the processes that yield them; an age that connects and breaks with tradition simultaneously; an age whose social transformations are moving so quickly beyond the institutions meant to mediate them that perception is gravely—though temporarily—impaired.

Instead, we have only artifacts. Sometimes machines, sometimes pictures, sometimes ideas in various stages from latency to manifestation. We are turn-of-the-century anthropologists, studying these artifacts in the hope that they'll yield a culture; we are necromancers, hoping they'll foretell a fate. In any case, interpreters, and touchingly old-fashioned in the act.

"The effects of a work are never a simple consequence of the circumstances in which it was generated," the poet Paul Valéry once wrote.
“On the contrary, we might say that the secret aim of a work is to make us imagine that it created itself, by a process as remote as possible from the real one.”

Aaron’s drawings seem to create themselves. And in a way, they do. The creative process is remote and abstract, but also very real, as we’ll see.

A viewer might be disquieted before the drawing machine. The image emerges, its bucolic cheer reassuring; yet, where’s the human artist? The machine, having replaced living muscle long ago, presently replacing the mind in an ever-widening series of tasks that once required human thought, is now making art, even.

All very well for the human artist to appear beside his machine—a benignly chunky presence, gray hair escaping impertinently from his little ponytail, a well-worn face turfed up by efforts to temper with sweet reason a mighty passion and intellect, a face turfed up by struggle and sorrow and skepticism, sweeping up the landscape with knowing brown eyes behind grandpa spectacles—all very well for him to reassure us that he means only to develop a theory, that all the machine does is to enact the understanding of visual representation embodied in its structure and put there by him.

The thing is making art. And look, ma, no hands on!

The thing evokes the original myths, all about breathing life into matter, endowing the creature of one’s own hand with freedom. In an eerily explicit way, the thing acts out the old and powerful metaphors of art as parturition, as doppelganger, as the ultimate gesture of overreaching ego—ancient tales, exhilarating and cautionary.

Aaron is the first example of art and its encounter with artificial intelligence. It’s a signal moment; Aaron is a signal event. As the best art always has, Aaron embraces, embodies, and comments upon some of the central ideas of late twentieth-century intellectual ferment. At the same time, Aaron is sly and full of subterfuge; persuasively read as a recapitulation of the history of art, of the individual’s maturation in art. Persuasively, an answer drawn deftly from art as well as from science to a question implicit in the language of art history: Significant Form, yes; but what makes it significant?

Just as persuasively, a creature whose like has never before been seen, out to transform everything in sight.
Beginning the Journey Back

Having passed through what he called the most traumatic event in his life since meeting computers, the Dokumenta 6 show at Kassel, Cohen was delighted to find that the show at Amsterdam's Stedelijk Museum was everything Dokumenta had not been.

The new computer, borrowed from Digital Equipment Corporation through the intercession of Ed Feigenbaum to his old friend Gordon Bell, then DEC's vice president for engineering, worked smoothly. The crowds flocked in and were obviously taken with the turtle, the little cart that moved over the paper and actually executed the drawings.

The installation was illuminated by a dialogue that was, in essence, the show's catalog. Harold and Becky Cohen had composed it during the course of the Kassel show (it read as Becky Cohen's questions and Harold's answers, but in fact they worked together on both the questions and the answers). It explained in some detail what was happening and answered questions that nearly everybody asked. More important, it gave Harold Cohen his first opportunity since conceiving Aaron to tell the world—and perhaps himself—what he was about.

The drawings that the turtle was making, no two alike, weren't entities stored somehow within the computer, he began, but were the result of certain rules in the computer's program. The turtle navigated
by a system of sonar feedback to the computer, emblematic of the whole program, which relied on feedback at every level from lowest to highest. The program was hierarchical, he went on to explain, with the very lowest level of the program working out a single step, each line requiring many such single steps, each figure requiring several lines, each drawing requiring several figures. There was no single, controlling part:

*Siedeljk Museum installation, Amsterdam, November 25, 1977, to January 8, 1978, showing the computer-driven "turtle" in action. On the wall is a large finished drawing; smaller drawings can be seen through the doorway.*
each level of the program exercised specific kinds of control. The lowest level would generate steps until the level above it recognized that the current line had been completed; then control was passed up to the next level, which would go on generating lines until it saw that the correct figure had been completed, and so on. The lower levels didn't decide whether the drawing as a whole was complete, just as the topmost level of the program did not control the turtle. Though the whole program described the entire drawing process, there was no way to predict from the program what any of its drawings would be. The program had to be run to find out.

When asked why the computer was valuable to him, Harold Cohen answered: “Mostly because of its explicitness, I think: the power it gives one to define the domain of investigation.” He reiterated his long-standing preoccupation with the nature of image-making. “For example, as an artist I am able to make some marks on a piece of paper, and the viewer may say, ‘That’s a face,’ when we both know the difference between a face and a few marks on a piece of paper perfectly well. Can you imagine a transaction more fundamental to art? I spent a long time as a painter trying to grasp what I was actually doing to initiate and control it.

“What the computer provided was a way of externalising, stabilising my speculations about image-making behavior: not only my own behavior, but what I thought I could see operating in drawings generally, and especially in children’s drawings and in so-called primitive art.”

Cohen described his changing views: he had once seen machines as objects whose properties were reasonably distinct from the properties of other parts of the environment, but now he saw them as the embodiment of a system of functions.

This insight not only led him to shift his own view of what the artist was, but also caused a genuine shift in what all artists were, he believed. He then took up one of his favorite themes: the pernicious effects of specialization, which he saw all around him, a result perhaps of the complexities of the twentieth century, but not an inevitable result. “Against this background you ask me whether my sense of what an artist is has changed. What I would hope to find is more flexibility, greater overview, a generosity of spirit that comes from a developed sense of what one is. What I find is that most artists are pretty much like any other specialists.”

Becky Cohen then responded that the installation at the Stedelijk itself raised questions about the nature of art and art-making, not the least of which concerned the relation of the artist to the rest of the population: “Almost continuously, both artists and public in the Western tradition have preferred the motives and methods of artists to remain secret and oblique. You differ from this convention in that you want everything about your activity as an artist to be as open and clear as possible. You are encouraging the audience to have a more questioning
Three examples of the “double-humped mountain” series that emerged after Cohen returned to London from New York. In Quadratic, painted some months after Almanac and Ascendant, the bands are beginning to break up, anticipating the next series of paintings, which will be one of Cohen's most fruitful periods.

Almanac. Harold Cohen, 1962. Oil on canvas, 22 x 90". (Photo: Harold Cohen)

Ascendant. Harold Cohen, 1962. Oil on canvas, 71 x 41". (Photo: Harold Cohen)

Quadratic. Harold Cohen, 1962. Oil on canvas, 66 x 33". (Photo: Harold Cohen)
Möbius. Harold Cohen, 1964. Oil on canvas, 48" x 58". (Photo: Harold Cohen)

As If. Harold Cohen, 1965. Oil on canvas, 102" x 102". Sheffield Art Museum Collection. (Photo: Harold Cohen)


response to art. You are offering the viewer a larger share in what you yourself would call transactions fundamental to art.”

Art is magical, and society would rather have more magic than less, Harold Cohen replied. But methodologies for marvelousness, however abstruse, have always been learned by initiates—“which means we should be talking about initiation into a body of knowledge, not about the possession of paranormal powers, when we talk about what makes artists special.”

Years later, he’d recall: “Once the show at the Stedelijk was up and going, and clearly going well, and people clearly loved it, I think I began to allow my confidence in what I was doing to build for the first time.”

In one of the great cities of the world, he’d begun the return trip from the desert.

The two European shows meant postponing the show at the San Francisco Museum of Modern Art, which didn’t take place until the summer of 1979, 18 months after the Stedelijk show. It too went very well and marked Cohen’s return to painting.

The San Francisco Museum’s director, Henry Hopkins, had given Cohen a big upstairs gallery, some 120 feet long, and suggested that one of the drawings be enlarged and done on the wall as a temporary mural. “People would see this huge black-and-white drawing on the wall, and then see the machine that was actually making the drawing; it sounded good. Then Hopkins said, ‘In color? Like red, blue, yellow?’ I thought, red, blue, and yellow? I haven’t seen that for a long time!’”

So it was done, with Cohen mixing the colors and conducting a team of his best students as painting assistants.

The catalog included a deeply perceptive essay by painter and writer Andrew Forge. If the drawings do have a characteristic look, Forge wrote, and indeed they did, this is not something aimed at from the outset. “All that one drawing has in common with another is its common origin within the structure of rules. That no two drawings are alike is the result of a minimal and highly controlled use of randomness throughout the program which causes the program to be ‘event-driven.’ The first ‘event’ is the random choice of a point to begin drawing. People who know Cohen’s pre-computer drawings and paintings often say that they can see his hand and eye in the computer work,” Forge wrote. “He expresses puzzlement at this. But how could it be otherwise? The ideas, convictions and practices of drawing from which he extrapolated his rules were his own, his life experience as an artist. Would another artist have extrapolated the same rules from his practice and experience? It seems doubtful. Having said this, one realizes just how astonishing Cohen’s achievement is, for there is nothing reductive, minimalist, about these drawings. For all their primitive flavor, their hallmark is variety, richness of change. His effort of analysis and synthesis which is behind
A viewer watches the turtle in action at the San Francisco Museum of Modern Art installation, summer 1979. In the background is a temporary mural, one of Aaron's drawings enlarged and painted in acrylics on plaster (see Plate 3), the first painting Harold Cohen had done since 1972.

the program is nothing less than a comprehensive critique of drawing. This looms over the impressive hardware and the delightful drawings themselves."
Harold Cohen chatting with gallery visitors at the San Francisco Museum of Modern Art, as he often does when Aaron is on exhibit. Cohen leans against a video terminal that electronically displays the picture Aaron has decided to draw before the drawing machine executes it in ink on paper. The computer was Cohen's Digital Equipment Corporation PDP 11/45 system.

Indeed, the San Francisco show appears to be the only occasion when Aaron's drawings were independently identified as Cohen's. People who'd known his work in the 1960s would see an exhibition and
proclaim that they recognized it as his work, recognized his hand in the drawings, even though they were watching a turtle actually execute Aaron's code. But Cohen never knew whether he believed them: after all, the exhibition had "Harold Cohen" over the door.

One day, however, while Cohen and his assistants were painting the mural, weeks before the show opened at the San Francisco Museum of Modern Art, they broke off and went to lunch. Cohen's name was not yet in sight, no documentation lay about. A European critic came to visit Henry Hopkins for lunch and said, "Who painted that mural? I can't place it at all; it reminds me very much of Harold Cohen's work, but I haven't seen his work for several years and don't know what he's doing."

Andrew Forge also commented on Cohen's desire for demystification: "He shows us a machine drawing. On one hand, he arouses a tremor of a familiar anxiety, endemic in our relationship with machines: can a computer draw? On the other hand, he is explaining something about the nature of drawing, its relation to thought rather than to skill, talent, inspiration, 'hand,' the artistic and indescribable. He is using the computer to explain. . . . His work splits conception and execution in a truly classical manner. Is the computer then his apprentice? It is a better image, with its implication of teaching and learning, than the computer as pencil or brush."

Cohen's hard thought about the nature of drawing had produced a program that made drawings, said Forge, "whose notched, inflected, wayward lines persuade us, at first sight, that somebody drew them."

And then, if somebody made the drawings, they must have meant something by them. "What then can we do with our persistent responses to the drawings? There is a tension here which alerts us to something important. Indeed, it may be that the most significant aspect of Cohen's work is the way that it opens up an unfamiliar angle on the issue of interpretation."

Forge went on to discuss what might be meant by meaning, intention, and their cultural contexts. "The computer drawings clarify, for with them there is no drawer, no relationship to drawing culture and therefore no intention vis à vis that culture. What then can we do with this self-contained world in front of us, a world charged, it seems, with life, with puffy clouds, beaming suns, wigwams, beetles, stones with eyes, flowers, a world irradiated with playfulness and chirpy good humor?"

We are thrown back on ourselves, Forge concluded. "If I understand him correctly, Cohen is telling us that art is, in the most general and universal sense, a kind of meditation on the power of the human mind to symbolize. It is a tonic message, deeply humanistic, and liberating, at least to anyone who has suffered the claustrophobia of the historicist tradition, whether in the form of art historical theory or the structures of the art scene."
That was the reason the murals for the show in the Tate, for example, were not done on the wall. They were portable, to be taken away afterwards."

There was another change. From here on, Cohen abandoned the turtle for more conventional drawing machines. The turtle had served its purpose: it had engaged and reassured a computerphobic public. But Cohen began to believe it was too cute, too beguiling. Its very cuteness distracted viewers from the main ideas he wanted them to think about.
One of the drawings made by Harold Cohen's program Aaron at the San Francisco Museum of Modern Art, 1979. "A world charged, it seems, with life, with puffy clouds, beaming suns, wigwams, beetles, stones with eyes, flowers, a world irradiated with playfulness and chirpy good humor," in the words of artist and writer Andrew Farge.

"By the time I got through with that show," Cohen would say much later, "I knew it was okay. There was no ending point to decide, the way there never is, but I was fairly sure I was on a good roll at that point."

What he hadn't counted on was the emotional attachment he felt to the mural, his first painting in so long. "You do a bloody great painting, figure this is by a long way the best painting you've done, and then they come in with white paint the next morning and destroy it. I'd agreed to that; it wasn't as if they were doing something I didn't expect. But I really had not understood how much pain it would cause me to see it go away. I made sure to be out of town by the time they came with the white paint.